

***KEYSPAN***

***ENERGY  
MANAGEMENT***

***COMBINED HEAT and POWER WORKSHOP***

*Energy Solutions  
Bottom Line Results.*

# ***INSTITUTIONAL CASE STUDY***

## ***Case Study Overview***

<input type="checkbox"/> <i>Site</i>	<i>Staten Island University Hospital - So.</i>
<input type="checkbox"/> <i>Installed Capacity</i>	<i>1,150 kW / 4.5 MM BTU/hr</i>
<input type="checkbox"/> <i>Commissioning Date</i>	<i>January, 1992</i>
<input type="checkbox"/> <i>Fuel Input</i>	<i>15.5 MMBTU/hr</i>
<input type="checkbox"/> <i>Peak Summer Load</i>	<i>1,200 kW / 20,000 lb./hr</i>
<input type="checkbox"/> <i>Peak Winter Loads</i>	<i>800 kW / 25,000 lb./hr</i>
<input type="checkbox"/> <i>Minimum Loads</i>	<i>400 kW / 1,500 lb./hr</i>
<input type="checkbox"/> <i>Plant Location</i>	<i>Adjacent to boiler room in new building</i>
<input type="checkbox"/> <i>Electrical Operation</i>	<i>Grid Parallel; grid Isolated Emergency Mode</i>
<input type="checkbox"/> <i>Major Equipment</i>	<i>CAT G399; CAT G3412 as packaged by Tecogen, Inc</i>
<input type="checkbox"/> <i>Emission Control</i>	<i>Catalytic Converter (retrofit)</i>
<input type="checkbox"/> <i>PURPA Qualified</i>	<i>Yes</i>

**KEYSPAN**  
ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM



















# *Topics*

- ☐ *Development process and schedule*
- ☐ *Fuel Utilization*
- ☐ *Construction Costs*
- ☐ *Energy Savings*
- ☐ *\$\$\$ Savings*
- ☐ *Reliability and Availability*
- ☐ *Ancillary Benefits*
- ☐ *Use as emergency generation system (isolated mode)*
- ☐ *Use for Peak Shaving*
- ☐ *Parallel Interconnection with grid*
- ☐ *Constructability and start-up in a Hospital setting*
- ☐ *Operations and Maintenance*
- ☐ *Steam Compression*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM

# ***Project Participants, Awards***

- ❑ *Brooklyn Union Gas*
- ❑ *NYGAS*
- ❑ *Staten Island University Hospital*
- ❑ *KeySpan Energy Management*
- ❑ *1995 - ASHRAE Technology Award*
- ❑ *Staten Island Chamber of Commerce Craftsmanship Award*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM

# ***Development Process and Schedule***

## *❑ DEVELOPMENT CYCLE MUCH LONGER AND MORE EXPENSIVE THAN ANTICIPATED*

- Design Iterations, Finance and Cost Iterations, Permits and Approvals*

*1986 Commence Feasibility*

*1989 Commence Design and Order Equipment*

*1990 (Fall) Break Ground*

*1992 (January) Commission and Acceptance*

- 3 to 4 YEAR DEVELOPMENT CYCLE; 18 MONTH CONSTRUCTION*
- TIME IS MONEY*
- LEGAL EXPENSES AND OTHER SOFT COSTS*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM

# ***Fuel Utilization***

## ☒ *EXPECTATIONS*

- *PROJECTED ANNUAL GAS LOAD INCREASE: 70,000 DTH/PER YEAR*
- *HIGH LOAD FACTOR FIRM GAS PROCURED AT TARIFF RATES*
- *IMPORTANCE OF FUEL SUPPLY and **COST CERTAINTY***

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM



# Construction Costs

## ❑ ACTUAL COSTS WERE GREATER THAN ANTICIPATED

❑ *Scope Additions*

❑ *Unrealistic Preliminary Estimates*

- |   |                      |
|---|----------------------|
| • <i>1st cut estimate (1987)</i>        | <i>\$1.3 MILLION</i> |
| • <i>Schematic Design Estimate</i>      | <i>\$2.0 MILLION</i> |
| • <i>Construction Document Estimate</i> | <i>\$2.4 MILLION</i> |

*ACTUAL COST*

*\$2.4 MILLION  
(APPROX \$2,000/kW)*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions, Bottom  
Line Results, SM

# Energy Savings

## DESIGN (PROJECTED) HEAT BALANCE FOR CATERPILLAR G399

	<u>kW</u>	<u>BTU/min</u>	<u>MMBTU/hr</u>	<u>BTU/kW</u>	<u>% TOTAL</u>
Heat Input Total, LHV	2,275	129,379	7.76	11,943	
Heat Input Total, HHV	2,525	143,611	8.62	13,256	
Work Delivered	650	36,963	2.22	3,412	26%
Internal Losses	44	2,502	0.15	231	2%
Exhaust Heat Recoverable	417	23,715	1.42	2,189	17%
Unrecoverable Exhaust Heat	246	13,993	0.84	1,292	10%
Radiation and Convection	91	5,175	0.31	478	4%
Jacket water recovered	668	37,989	2.28	3,507	26%
Aftercooler reject	45	2,559	0.15	236	2%
Oil cooler reject	114	6,483	0.39	598	5%
LHV - HHV Loss	250	14,232	0.85	1,314	10%
TOTAL	2,252	143,611	8.62	13,256	100%
TOTAL RECOVERABLE					69%

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM

# Energy Savings (cont')

## ✓ ACTUAL PERFORMANCE

### ANNUAL ENERGY DELIVERY:

Gross Generation	5,309 MWH (el.)	18,115 MMBTU
Net Generation	5,171 MWH (el.)	17,644 MMBTU
Electric Import	1,081 MWH (el.)	3,689 MMBTU
Steam	6,475 MWH (th)	22,094 MMBTU

### ANNUAL FUEL CONSUMPTION (PEAK SHAVING FUEL)

70,392 MMBTU HHV  
4,341 MMBTU HHV

### UNIT VALUES

Gross Heat Rate	13,259 BTU/kWH	(13,256 Projected)
Thermal Recovery	4,162 BTU/kWH	( 5,696 Available)

### FUEL CHARGEABLE TO POWER

9,452 BTU/kWH

### FUEL EFFICIENCY

56.5%

### PURPA EFFICIENCY

45.2% based on LHV

### "BUBBLE" FUEL SAVINGS

21.0% (Compared to conventional)

**KEYSPAN**  
ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions. Bottom  
Line Results. SM

# \$\$\$ Savings

❑ *Less Than Anticipated*

*PROJECTED SAVINGS, exclusive of capital recovery*

\$228,000

## **1st YEAR ACTUAL COSTS**

**\$375,775**

FUEL

\$286,519

O&M

\$ 89,256

## **1st YEAR SAVINGS IN UTILITY CHARGES**

**\$580,536**

ELECTRIC DEMAND

\$152,848

ENERGY

\$326,380

STEAM RECOVERY

\$101,308

## **SAVINGS (1st YEAR)**

**\$204,761**

## **SAVINGS (subsequent years)**

**\$125,000-\$175,000**

## **REASONS FOR MARGINAL ECONOMICS**

*Additional expenses (e.g.catalyst retrofit)*

*Increase in tariff gas costs*

*Short duration "trips" (less than one hour) results in demand charge*

*Minimum demand charge*

*Important electricity greater than anticipated (control issue)*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions,  
Bottom Line Results, SM

# ***Reliability and Availability***



*Exceeded Expectations*

<i>Plant Availability</i>	<i>99.897% 1st</i>	<i>99.868% 2nd year</i>
<i>Main Engine</i>	<i>98.482% 1st</i>	<i>96.42% 2nd year</i>

***In the first year***

*10 Forced outage hours*

*Successful peak shaving 792 out of 796 hours*

*1/2 hour is sufficient to incur demand charge*

*Subsequent years - 90% - 99%*

*Overhauls last one full week*

*Several trips were more than nuisance*

*(valve swallowed, exhaust pipe problem, retrofit catalyst)*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions,  
Bottom Line Results, SM



# *Use as Emergency Generation System (isolated mode)*

## ☒ *Met Expectations*

- *Automatic switch - over to isolated mode*
- *Usually successful if site load < engine capability*
- *Black start required if site load > engine capability*
- *Complicated control scheme, technical issues*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM

# *Use for Peak Shaving*

## ☒ *Met Expectations*

- *Second backup engine used in Summer to meet added 400 kW load*
- *Successful on average 2 out of 4 months in “picking up” demand savings*
- *Redundancy is lost when peak shaving*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM

# ***Parallel Interconnection with Grid***



*Successful paralleling, Auto resynch*

- Detailed study is required*
- Host utility was professional and helpful after project was clearly a GO*
- Paralleling Switchgear and Relay Protection meets Utility standards*
- Fair interconnect charges were assessed ( \$35K )*
- Problems with utility distribution system effects parallel connection - demand charges should be waived for these instances*
- Ancillary benefits must be valued*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM

# ***Constructability and Start - Up in a Hospital Setting***

✓ *Minimum impact due to green - field site*

- *Outages are required to make critical electrical, steam connections*
- *Several short duration disruptions during start - up*
- *Control system debug*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM

# *Operations, Maintenance and Costs*

- ☐ *Critical parameters are monitored*
- ☐ *Water Treatment is Mandatory (ebullient cooling, HRSG)*
- ☐ *Monthly engine oil changes ( at night ) necessary*
- ☐ *Top end overhauls annually*
- ☐ *Balance of plant servicing*
  
- ☐ *Failures include air handling unit - bearings, battery charger switchgear breaker, exhaust pipe*
- ☐ *Key plant components: Heat Recovery boiler, fluid cooler, air compressor , water treatment, back - up engine radiators, motor control center, pumps, controls, emission control, ventilation system, switchgear*
  
- ☐ *Major overhauls - 30,000 hours*
- ☐ *Average unit O&M costs: 1.6 to 2.4 cents per kWh*
- ☐ *Hidden costs: Additional time required of operators*
- ☐ *Operators are important : semi - attended operation is necessary*

**KEYSPAN**  
ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions,  
Bottom Line Results. SM



# CONCLUSIONS

- ❑ *Plant is reliable, not perfect*
- ❑ *Costs (construction and operating) are greater than anticipated*
- ❑ *Development cycle is longer than anticipated*
- ❑ *Savings alone would not justify this project*
- ❑ *Fair value for ancillary benefits would enhance economics and justify this plant class*
- ❑ *Usefulness as emergency generation system was proven : reliable, but not perfect*
- ❑ *Back up tariffs should be fair and market based*
- ❑ *Economics, not PURPAnomics, should influence this market*
- ❑ *Long Term Planning and Thinking is essential*

**KEYSPAN**

ENERGY  
MANAGEMENT  
COMPANIES

Energy Solutions.  
Bottom Line Results. SM